

Interim Progress Report submitted to NOAA's Human Dimensions of Global Change Research (HDGCR) Program

**Project Title: Climate Variability and Household Welfare in the Andes:
Farmer adaptation and use of weather forecasts in decision-making
May 2001-April 2002 NOAA Award No. NA96GP0239**

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I. Preliminary Materials

A. Project Abstract (1 page)

B. Objectives of the Research Project

This project aims to answer three research questions: 1) What have farmers developed as successful strategies to cope with climatic variation in the Andean region; 2) How do farmers currently use information from forecasts and local sources to make production and consumption decisions; and 3) What mechanisms and institutions facilitate or constrain the utilization of information about climatic risk. The project spans three years. The first objective of this research is to determine the interactions between climate and a set of factors that affect the coping strategies of households in the rural Andean region of Bolivia and Peru. Among the factors are markets for outputs and inputs, household assets and access and claim capacity, indigenous/local knowledge, life cycle characteristics. The

second is to understand the relationship between these identified groups and their knowledge and use of climate forecast information (local or probabilistic) in production decisions. Specific objectives include development and application of a methodology that identifies the role of climatic risk in the choice of economic activities, levels of production and of consumption at the household level, in agropastoral communities of Bolivia and Peru; Measure of the impact of El Niño event of 1997-1998 in a peasant community of the Central Altiplano of Bolivia; Evaluate information flows, networks, transactions costs, and mechanisms that rural communities have to access climatic and weather information. Finally, based on these results assist in identifying the characteristics of climatic information delivery systems suited for Andean agriculture.

C. Approach (including methodological framework, models used, theory tested one page)

The overall framework of our research is the livelihood strategies approach informed by microeconomics, political economics and sociology. Within this framework we focus on two areas, the household economic strategies and portfolio that establishes a relationship between household access and control of resources and assets, their life cycle characteristics, and the composition of each strategy and set of economic activities. We use a panel study approach that looks at changes overtime, which include negative climate shock events. Cluster analysis, regression analysis and canonical correlations are used to analyze the quantitative data generated from the rural household surveys of three agropastoral communities.

A case study approach is used for the qualitative segment of our research. A multiple embedded design is used to compare the characteristics and diverse strategies of groups of households, to analyze the diversification strategies focused on potato production. This design is also used in the communities of Peru to analyze the transaction costs that preclude farmers from fully participating in the market. Both, the study of potato and household diversification and coping strategies, and the study of transaction cost that preclude from relying fully on the markets also have a regression analysis component to complement the findings of the case studies. The purpose of the latter is to test the relationships between factors and strategies.

The analysis of access to climate forecast information includes case studies of community networks, as well as interviews with institutions that provide some form of forecasts, probabilistic and local knowledge. The methods used included focus group interviews, participatory meetings, and formal surveys to identify the types of networks, the nodes of information and the type of information flow.

Biophysical models are useful to simulate scenarios that can be shared with farmers. Our household surveys included questions about the production inputs, soil types, feed resources, yields and total outputs. Our collaborators did some experimentation on farmers' fields to gather data to calibrate biological models. Potato varieties are modeled, as are performance of animal species. Agroecological zoning maps are constructed to understand the land use potential. These maps combined with biological maps will be used to understand what are the possible outcomes of various climate events. These can also be used to inform producers of climate using agricultural outcomes.

Following are the working hypothesis of this research. Access to resources, stage in the life cycle, livestock assets, quality of resources, and off farm employment is significant variables in developing distinct economic portfolios. These along with networks and experience with climatic information, are predictors of use of forecasts. High transactions costs preclude farmers and household's access to climate information. Farmer and household diversification strategies minimize climatic risk and result in lower net income returns (following Rosenzweig and Binswanger, 1992). Climatic information will be used only if risk-reducing technologies are available.

D. Matching Funds (one paragraph)

Both the University of Missouri and the International Potato Center are matching with faculty and research time in accordance with the proposal. Besides this matching we have obtained support from the Department of Agricultural Economics for a quarter time assistantship for three years supporting Susan Materer and Cheston Easter. We have complemented the funding for graduate research from the grant with funds from the Department of Rural Sociology for a doctoral student.

We also obtained funding from Dorris D. and Christine M. Brown Research Fellowship, International Agriculture Programs, College of Agriculture Food and Natural Resources of the University of Missouri-MU for Easter and Materer's field research in Bolivia and Peru. The Social Sciences Unit (in which Agricultural Economics is housed) provided funding for Valdivia to present at the AGU Conference in May 2002. The University of Missouri provided a short-term leave with funding to spend two weeks at the International Research Institute for Climate Prediction to learn about the institutions working in the applications of climate forecasts. The International Center for Tropical Agriculture in Cali Colombia, (CIAT) provided funding for Valdivia to present NOAA research finding at the Integrated Natural Resource Management Workshop.

E. Interactions with Decisions-makers

Our project includes collaboration with local institutions as partners or as members of our Expert Panel. We collaborate with PROINPA (Javier Aguilera and Ramiro Carrillo) at Foundation for the Promotion of Andean Crops) in La Paz Bolivia and with CIRNMA (Roberto Valdivia and Jorge Reinoso at the Center for Research on Natural Resources and the Environment) in Puno Peru. With both institutions our focus has been to understand how climate plays a factor in the design and promotion of technologies for rural households. PROINPA decided to work in the community that consented to participate in our research. Our research on the roles of potato varieties in household strategies, potato diversity and climate, showed that households' priorities for selection are varieties that have more than one trait: marketability, adaptability, and taste. Information was generated on varieties that were drought and frost resistant for PROINPA to use in technology design and marketing of varieties. With CIRNMA we collaborated in two of their research and outreach communities, in the area of climate and local knowledge forecasts. This Non Governmental Organization promotes diversification of activities in the Altiplano. They also promote livestock activities and forage production, an activity of less risk to drought and frost once established.

F. Interactions with climate forecasting community

IRI Collaboration with Dr. Jennifer Philips. Developed and received funding for a faculty development leave from the University of Missouri to spend two weeks at IRI in their applications area, January 7 through the 19th, 2002, and learn about institutions in Latin America and Africa. Finally will participate in the Advanced Training Institute on Climate Variability and Food Security, organized by Jim Hansen, addressing primary data collection, livelihoods and coping strategies framework in July.

Instituto Geofísico del Peru Collaboration with Dr. Pablo Lagos, informing us of the current conditions for forecast in the Andean region. He participates in the expert panel meeting.

Sistema Nacional de Seguimiento de la Seguridad y Alimentaria y Alerta Temprana SINSAT Bolivian Institution in the area of use of climate forecasts (National System of Food Security and Early Warning), with Javier Choquevilca, coordinator to participate in the expert/advisory panel, and to develop a case study of this organization about delivery of information.

World Food Program Bolivia Exchange of methodologies with Carmen Barragán. She works with vulnerability mapping in Bolivia.

Leeds University Projects on Natural Hazards: David Preston, Senior Fellow, School of Geography. University of Leeds, UK, working in Tarija Bolivia. We are exchanging research results.

G. Coordination with other projects of the NOAA Climate and Societal Interactions Integrated Sciences and Assessments

With Dr. Jennifer Phillips, participated in Conference June 6th-8th 2001 at IRI, Palisades, New York. "Workshop on Communication of Climate Forecast."

H. Brief Discussion of Research Tasks Accomplished.

Household Portfolios and Livelihood Strategies

Field data collection was completed in the third year of research. The second household survey applied in Bolivia (45 families) was entered and cleaned and the data is ready for analysis. A database of 110 households for Peru was cleaned and the variables prepared for analysis through July of 2001. As anticipated the variables were discussed and agreed to at the Expert Panel Meetings in Puno. This data was used for the first cluster analysis to identify groups with different income sources/ household portfolios. This information was used to select the households for the case study on transaction costs research.

Fieldwork was conducted between May and August of 2001. The purpose was to identify which household characteristics, and transaction costs factors affect market participation of households in Puno. A second survey was applied in Puno, taking advantage of the network study being conducted. The data has been entered and is currently being cleaned with the support of CIP. Completed the monitoring of families in

Santa María and San José to look at the dynamics of family strategies. A summary monograph has been prepared in Spanish, from which an article is planned.

Findings

Diversification is central to the managing resources, assets and engaging in productive activities at the household level. Climate affects coping and adaptation of households, and it has for generations in the Altiplano Region, of both Bolivia and Peru. The ability to cope and adapt depends on the stage in the life cycle, the quality of resources, assets and land the household controls and accesses, and the market and non market institutions that exist in the structure where strategies to pursue rural livelihoods are constructed. In the case of Bolivia, markets and policies that create opportunities for some households to benefit trigger diversification of economic activities. Others, mostly older people but also resource poor farmers (as a function of the quality of resources they can access and control) have more difficulty keeping the levels of portfolio diversification through time. In the study of potato diverse roles in households adaptation and coping strategies, chuño, a freeze dried potato, was an indicator of storage and ability to cope during scarcity, but also could be sold for larger income due to the processing. Women in these communities, as we found in Bolivia, play an important role in choosing which varieties to plant. Market traits (through case study research) were an important motive for adopting varieties in San José. Potato production has grown to become a commercial activity for some households, but the diversity index of these households has decreased, indicating more vulnerability to climate variability.

In Peru preliminary cluster analysis identified four groups, instead of the general three identified in Bolivia, a younger group with less access to resources, engaged in employment outside the farm. The main difference was that asset poor farmers were able to access markets for labor, and this was the main income generating activity for one group. A study of transactions costs on market participation showed that farmers from Santa María had easier access to the markets, and more market participation. This study shows that market integration allows younger families to rely on work off the farm. Farmers express pride of being able to maintain their families through farming, and not have to rely on the markets. Dual motives of production, for consumption and for market, were found in Peru with less emphasis on the marketing side in the case of crops, as compared to the Bolivian community. Livestock were the main selling activity, motivated by large cash needs.

Local Knowledge Networks

Bolivia Activities and Findings:

The primary activities in Bolivia were to write up the results of the ethno-graphic studies of networks of forecasting information that were developed from the ethnographic studies of the previous year.

Findings Local Networks/San Jose Llanga:

1. In general agro-climatic information networks were organized by neighborhoods, but there were two individuals who were recognized experts at the community level. In general there were links between neighborhood experts.
2. Although most people knew traditional weather lore, it involves multiple indicators so the key to forecasting was the manner in which multiple indicators were weighed. Because of this, most people referred to local experts in their neighborhoods. These local experts were generally those people who were recognized to be superior potato producers. Many people only observed the planting and plowing operations of these nodes and did not have direct conversation with them.
3. Local experts did exchange information with experts (nodes) in other neighborhoods but most families did not.
4. Forecasts generated through scientific forecasts were not used by nodes or by other community members. Although almost everyone listened to Aymara language programs using traditional forecasts, they were not used in decision-making. Traditional forecasting is believed to be locality specific.
5. Although sources of climatic information tended to be older (60+) there was no apparent difference in knowledge about traditional forecasting indicators between these persons and persons who were 40-60 years of age. Younger people particularly those less than 30 appeared to be less connected to local forecasting systems.

Extra-Local Networks Radio San Gabriel and SINSAAT Findings:

We looked at two external community sources of information SINSAAT (National System for Early Warning on Food Security) and Radio San Gabriel. SINSAAT is supposed to coordinate the gathering of information and dissemination of climate forecasts related to agriculture. It works with SEHNAMI and AASANA to generate forecasts, but SINSAAT has the responsibility of translating them for use by agriculturalists. SINSAAT also has a program of price reporting.

1. At the current time, SINSAAT is emphasizing infrastructure development and will only begin to develop a diffusion system with the assistance of a European Union grant. This system will focus on training people at the “municipio level” to understand and use forecasts.
2. At present agriculturally related forecasts are developed by zone and delivered by radio and by bulletins. Present format and timing of releases does not fit well with the decision making calendar of farmers. Farmers decide where to plant (and thus plow the land) and when and what to seed. These decisions are usually made in August/September or earlier. Forecasts tend to come later.
3. Radio San Gabriel has a morning program in the Aymara language that includes forecast information. It uses short-term forecasts from technical forecasting agencies as well as bio-indicators.
4. The Bolivian meteorological agency SEHNAMI, currently does not have a program for distributing forecasts to producer groups, but it hopes to develop such a program using European Union funds to link with *municipio* (municipal) governments. This approach will probably not incorporate local forecasting

experts because these do not seem to have important contacts with extension agents or local governments.

Peru/Puno Activities and Findings:

In Puno we wished to develop a survey methodology to identify local nodes in climate information distribution networks and to also develop a more cost-effective way of identifying local climate forecasting knowledge. A questionnaire was developed and administered in October and November of 2001 in the communities of Anccaca and Santa Maria. Thereafter case studies of nodes were conducted and results of the study were coded early in 2002. Coding and analysis of data is now underway.

Preliminary findings:

1. Although the Peruvian government has a program through SEHNAMI to distribute weather forecasts to agriculturalists at the provincial level, low-income rural producers do not use these forecasts. The format (bulletins in Spanish) and the timing of forecast information may impede their use.
2. Residents of the communities in Puno were aware of and/or utilized a much larger number of climatic indicators than residents of San Jose Llanga in Bolivia.
3. Community meetings—especially in Santa Maria were a major forum for the exchange of climate forecasts and related information. This was much less the case in Bolivia.

With Erin Feinauer-Whiting a Ph.D. student in rural sociology, work on the coding of traditional weather forecasts to determine if the characteristics of nodes are different than those of other people in the villages.

Biological Models

The focus of this component of the project is to develop the capacity for modeling technological options under climatic variations in the high-plateau. The tasks included: 1) definition of agro ecological zones in the watersheds where the target communities are located, 2) the adaptation of crop and livestock models to the soil, climate, and management conditions of the area, 3) ex-ante assessing the expected outcomes of production decisions using biophysical models (scenarios), 4) the development of tools for integrating climatic, soil, and management conditions at different spatial scales, 5) training stakeholders in the use of tools and methods developed.

Preliminary findings Agro ecological zoning

Agroecological zoning (AEZ) is a method that uses biophysical attributes of the land to cluster land-use types into more homogeneous areas. This exercise facilitates planning for the sustainable use of natural resources, particularly in areas with high climatic variability. The application of AEZ is limited by the lack of geospatial data, particularly in mountainous areas. Remote sensing and process-based models for both climate interpolation and crop and livestock production were used in the Ilave-Huenque, Peru watershed above 3,800 m. The results are shown in Figure 1 (Annex 1). Only 31,000 ha

out of the 780,000 in the watershed can be used for mixed crop-livestock systems. The communities where the project is working at (Santa Maria and Anccaca) are representative of this portion of the watershed. Crop productivity is highly variable and is a function of climate variability.

Preliminary Findings Simulation Models

Crop and livestock simulation models were developed or adapted for the agro ecological conditions of the high plateau. Field experiments were conducted to calibrate the mathematical equations to describe the biophysical processes under cold temperatures and drought stress. Figure 2 (Annex 1) shows the confidence interval of biomass production for three potato varieties throughout the growing period. The results show that the model tends to overestimate the aerial biomass of the plant in the early development stage but as the plant matures, the simulation lies in between the 95 % confidence interval of the experimental data. The simulation at harvest time is the critical one, so the models can adequately simulate the expected yields under stressed conditions and can now be used to assess the expected yields under climatic changes.

Preliminary Findings Scenarios

Once the simulation models are validated they can be used to explain the impact of climate variability and to ex-ante assess future risks. Rainfall, and temperature patterns and the presence or absence of ENSO events are not enough to explain the behavior of crops (Figure 3 Annex 1) under climatic stress. For instance, the seasons 82-83 (or 3 in the sequence), 86-87 (7), 91-92 (12), 92-93 (13), 94-95 (15), and 97-98 (18) were El Niño years. It is evident that the behavior of the climate in the highlands was different for all of those years. A similar trend is seen for La Niña (88-89 and 95-96). As can be seen in the graphs, there is not a direct relation between the presence/absence of an ENSO event and potato yield. A closer look to rainfall, average minimum temperature and absolute minimum temperature indicates that even these average figures do not correlate well with potato yield. The distribution, intensity and duration of rain or frost events are the determinants of crop behavior. For instance, water logging in critical periods explained the very low yields in 84-84 and 95-96, whereas higher yields were attained in 81-82 with similar average values of rainfall and temperature. The simulation models thus constitute a valuable tool to integrate the different factors affecting crop yields and are useful to develop alternative technologies to cope with the impact of climate variability, once the forecasting skill improves.

Figure 4 (Annex 1) shows an example of the use of models in livestock production. The models were built and validated with farm data and then used to assess the impact of technological options to increase household income. It is interesting to note that the introduction of alfalfa is an alternative that not only decreases the negative impact of climatic variability on the economic activities of the farmers but also increases income through milk production. An additional benefit from strategic supplementation to dairy cattle comes from the environmental side. The environmental cost of producing milk, in terms of methane production, increases with low quality roughages and less efficient

animals, particularly during the Andean winter. This cost is reduced substantially with adequate supplementation.

The tools for up- and downscaling are being developed. A preliminary version is already operational. The final report will include the applications in the research zones. Training in the development and use of systems analysis tools is a continuous activity of the project. Not only the institutions collaborating have been using the models developed for the Andes, but also undergraduate and graduate students in local universities.

I. List of Outputs to Date: papers, presentations, workshop, journal articles

On Line Agricultural Economics Working Papers published 2002

Valdivia, C., C. Jetté, R. Quiroz, J. Gilles and S. Materer. 2001. "Peasant Household Strategies in the Andes and Potential Users of Climate Forecasts: El Niño of 1997-1998." Agricultural Economics Working Paper AEW-2001-4. Department of Agricultural Economics, University of Missouri. Columbia, MO.

Materer, S., C. Valdivia and J. Gilles. 2001. "Indigenous Knowledge Systems: Characteristics and Importance to Climatic Uncertainty." AEW-2001-03. Department of Agricultural Economics, University of Missouri. Columbia, MO.

Materer, S. and C. Valdivia. 2000. "Analysis of a Climatically Variable Production season." AEW-2000-10. Dept. of Agricultural Economics, University of Missouri. Columbia, MO.

Materer, S. and C. Valdivia. 2000. "Household Production Strategies in a Climatic Variable Zone." AEW-2000-9. Dept. of Ag. Economics, University of Missouri. Columbia, MO.

Workshops

Climatic Variability and Household Welfare in the Andean Region. Second Expert Panel and Scientific Meeting. NOAA. July 10-12 , Puno, Peru, and 16-17 La Paz, Bolivia. 2001. Two separate meetings were held as a result of political unrest that precluded travel in the Altiplano.
(Program and abstracts available at <http://www.ssu.missouri.edu/clima/SegundoPanel>)

Presentations in Puno, Peru July 10-12 (Hosted by CIRNMA).

Valdivia, C. 2001. Variabilidad Climática y Bienestar Familiar en los Andes: Adaptación del Productor y Uso de Pronósticos en la Decisions. (Climate Variability and Household Welfare in the Andes: Producer Adaptation and Use of Forecasts in Decisions)

Valdivia, C., C. Jetté, R. Quiroz, J. Gilles, R. Carrillo, R. Valdivia, J. Reinoso, E. Ortega, C. Guerra y M. Cruz. 2001. Estrategias de Vida y Perturbaciones Climáticas en Dos

Zonas de Altiplano. (Livelihood Strategies and Climatic Perturbations in to Zones of the Altiplano)

Gilles, J. L., C. Valdivia and R. Espejo. 2001. Reconsiderando El Vínculo Entre Productores y Pronósticos Climaticos. (Re-Thinking the Linkage Between Producers and Climatic Forecasts)

Materer, S. and C. Valdivia. 2001. Estrategias de Vida y Variedades de Papa en una Comunidad Boliviana. (Livelihood Strategies and Potato Varieties in a Bolivian Community)

Easter, Cheston. 2001. Productores Rurales y Costos de Transacción, un estudio de caso (Rural Producers and Transaction Costs, A Case Study)

Valdivia, Roberto, Edith Ortega and Carmen Guerra. Andes Clima Puno Peru Estrategias Familiares, Estudio de Caso en dos Comunidades, Santa María y Anccaca (Andes and Climate in Puno Peru. Family Strategies A Case Study of Two Communities, Santa María and Anccaca)

Baigorria, Guillermo and Roberto Quiroz. Hacia un Entendimiento del Impacto Biofisico de la Variabilidad Climática (Towards an Understanding of the Biophysical Impact of Climate Variability)

Lagos, Pablo. El Instituto Geofísico del Perú. Pronósticos de Tiempo y Clima para los Andes. (The Peruvian Geophysical Institute. Weather and Climate Forecasts for the Andes)

Claverías, Ricardo. Cultura y Resiliencia en los Sistemas de Producción en las Comunidades de Puno. (Culture and Resiliency in the Production Systems of Puno Communities)

Presentations in La Paz, Bolivia. July 16-17 (Hosted by UNDP).

Carrillo, Ramiro. Estudio del comportamiento de la producción de papa en San José Llanga: Segundo Año (Study of the performance of potato production in San Jose Llanga: Second Year)

Espejo, Rigoberto and Ramiro Carrillo. Pronósticos Locales y Redes de Información Agroclimática. Estudio de Caso San José Llanga (Local Forecasts and Agro-climatic Information Networks, A Case Study of San Jose Llanga)

Espejo, Rigoberto. Redes de Información Climática en San José Llanga (Climate information networks in San Jose Llanga)

Gilles, Jere. Perspectivas de los Pronósticos Climáticos: Nodos y Redes (Insights in to the Climate Forecasts: Nodes and Networks)

Materer, Susan and C. Valdivia. Estrategias de Vida y Papa (Livelihood Strategies and Potatoes)

Abstracts

Valdivia, C., R. Quiroz, P. Zorogastua and G. Baigorria, 2002. Climate Variability, Andean Livelihood Strategies, Development and Adaptation in the Andean Region. Invited presentation Climate and Development From Seasons to Centuries: How Our Understanding of and Responses to Seasonal Climate Variability Can Build Insight into Human Adaptation to Long-Term Climate Change. S 123. 2002 Spring Meeting American Geophysical Union Vol 83, No 19, 7 May 2002.

Valdivia, C. 2001. "Andean Livelihood Strategies and the Livestock Portfolio." *Abstracts American Anthropological Association 100 Annual Meeting*. Invited Session, Contentments and Contentions: Living with Livestock. November 28- December 2. Washington DC. Abstract p 437 Arlington VA

Gilles, J., S. Materer, and C. Valdivia. 2001. "Re-evaluating Climate Forecasting: Lessons from Indigenous Systems." *64th Rural Sociological Society Meetings*, August 15-19. Albuquerque New, Mexico. Abstract available.

Valdivia C, J. Gilles, R Espejo and R. Carrillo. Current Users and Diffusion Nodes of Local Climate Forecasts in the Andes of Bolivia: Lessons on potential users, timing and content of climate forecast Communications. P. 31. IRI Communication of Climate Forecast Information Workshop Proceedings. June 6,7 and 8 2001. Palisades NY.

Presentation Papers

Valdivia, C. and R. Quiroz. 2001. "Rural Livelihood Strategies, Assets, and Economic Portfolios in Coping With Climatic Perturbations: A Case Study of the Bolivian Andes." Presented at the Social Organization and Land Management Session, Integrated Natural Resource Management for Sustainable Agriculture Forestry and Fisheries, 28-31 August, International Center for Tropical Agriculture, CIAT, Cali Colombia. (Submitted paper for a special edition being prepared by CIAT)

Valdivia, C. 2001. "Andean Livelihood Strategies and the Livestock Portfolio." *Abstracts American Anthropological Association 100 Annual Meeting*. Invited Session, Contentments and Contentions: Living with Livestock. November 28- December 2. Washington DC. Arlington VA (submitted paper for special edition Culture and Agriculture)

Monographs

Materer, Susan Completed August 2001 “The Role of Potato Production in Diversified Household Economic Portfolios: Study of San José Llanga, Bolivia” Unpublished MSc Thesis. Agricultural Economics University of Missouri Columbia.

Easter, Cheston Completed May 2002 “Effects of Transaction Costs and Household Participation. Market Integration Within the Southern Highland Region of Peru.” Unpublished MSc Thesis Agricultural Economics University of Missouri Columbia.

Seminars

Valdivia, C. Climate Variability and Household Welfare in the Andes. NOAA Office of Global Programs, Washington DC. November 30, 2001.

Valdivia, C. Dealing with Climate and Other Changes in the Andes of Bolivia: Rural Households and their Strategies. International Research Institute for Climate Prediction, Palisades NY. January 16, 2002.

Related Publications (not directly funded by NOAA but that benefited from the PI’s presence in Bolivia in 1999 when the project started)

Valdivia, C. 2001. “Household socioeconomic diversity and coping response to a drought year at San José Llanga.” Chapter 6 in Coppock, D. L. and C. Valdivia (eds). *Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San Jose Llanga*. Rangeland Resources Department, Utah State University. Logan, Utah. 266 pp.

Markowitz, L. and C. Valdivia. 2001. “Patterns of technology adoption at San José Llanga: Lessons in agricultural change.” Chapter 7 in Coppock, L. D. and C. Valdivia (eds). *Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San Jose Llanga*. Rangeland Resources Department, Utah State University. Logan, Utah. 266 pp.

Coppock, D. L., C. Valdivia, J. Yazman, C. Jetté, J. de Queiroz, L. Markowitz and I. M. Ortega. 2001. “Conclusions and Recommendations.” Chapter 8 in Coppock, D. L. and C. Valdivia (eds). *Sustaining Agropastoralism on the Bolivian Altiplano: The Case of San Jose Llanga*. Rangeland Resources Department, Utah State University. Logan, Utah. 266 pp.

Technical Reports

These are field research reports as well as papers prepared for submission to journals.

Espejo, Rigoberto. 2002 Pronósticos Climáticos Locales de San José para la Campaña 2001-2002.(Local Forecasts for the 2001-2002 Production Cycle in San José) Technical Field Report, mimeograph.

Valdivia, Roberto, Edith Ortega, Carmen Guerra, and Corinne Valdivia. Estrategias Familiares en dos Comunidades de Puno (Family Strategies in Two Puno Communities). Reporte Técnico, CIRNMA. Technical field report.

Materer, Susan and Corinne Valdivia. Diversity Through Potatoes: Study of Livelihood Strategies in the Bolivian Altiplano (In preparation for Mountain Research and Development).

Materer, Susan and Corinne Valdivia. Impacts of Climate, Age, Education and Resources on Coping Strategies in the Bolivian Altiplano. (In preparation for Agricultural Economics).

Valdivia, Corinne and Christian Jetté. Climate Variability and Household Welfare in the Andes (in preparation for World Development)

Valdivia, Corinne, Jere Gilles, Rigoberto Espejo and Christian Jetté. Agriculture, Livelihood Strategies and Local Knowledge Climate Information Networks in the Andes. Valdivia, Corinne, Christian Jetté and Roberto Quiroz. Rural Livelihood Typologies of Technology and Policy to Address Adaptation. (Agricultural Systems)

Easter, Cheston, Corinne Valdivia, and Harvey James. Transaction Costs and Households Characteristics in the Market Integration of Rural Households of Southern Peru.

J. Discussion of any significant deviations from proposed work plan

Two events delayed the outputs of this project. The first took place from June through July in the Bolivian Altiplano. A farmer organization led a protest, closing down major roads that communicate Peru and Bolivia. This precluded us from holding joint meetings. This was a constraint because the field work on networks required the Bolivian sociologist to work with the Peruvian sociologist and Professor Gilles. The work could not start until September-October, when Dr. Gilles was able to return to the Altiplano to work with the researchers.

The second was the unexpected change of travel plans of the co Principal Investigator from CIP, Dr. Roberto Quiroz. He was scheduled to spend two weeks in Columbia MO in November, taking advantage of a meeting he attended in Minnesota. The purpose was to work on integrating the biological models with the identified household portfolios. He had to return to Peru because he was urgently needed at CIP. We have scheduled to work during the month of August 2002 at CIP.

As a result of these delays we are requesting a no cost extension. We are now planning to hold an end of project conference at the end of the year, or the beginning of next year,

instead of the one we held during the month of July. We need the time to prepare the final research papers for presentation at this meeting.

Finally we were able to apply more questionnaires than expected, by coordinating the work of household strategies with the work of networks. As a result we have more data to analyze and to write about that will take more time than anticipated.

In terms of the research we had proposed in the original project to study the household's transactions costs in accessing forecast information. We found that even though a portion of the households heard about El Niño event, this has not yet entered that decision making process for agricultural production. The networks case studies in both Bolivia and Peru are finding this. What we have done is study how access to information on technologies (improved livestock technologies) along with other transaction costs indicators and household characteristics influence market integration. Our reasoning was the following. Information on forecasts is a new technology, as are the ones on agricultural products that households are experimenting with and incorporating. So we use the proxy of livestock technology, which we found to be positively correlated to market participation, as a proxy for the potential effect that climate forecasts will have. This research was conducted in Peru.

II. Relevance to the field of human environment interactions

- A. Describe how the results of your project are furthering the field of understanding and analyzing the use of climate information in decision making (1 page)

Profiles of potential users of forecasts: Our research on household portfolios and livelihood strategies shows that diversification is pursued with different degrees of success. As a result, information needs are not homogeneous. Some producers are more interested in livestock related technologies, others in the production of food crops. Our research also shows that some groups (the elderly and resource poor) are more vulnerable to events like El Niño, but also to excessive rains as has happen in the last two years. In collaboration with PROINPA we found that households using cleaned local potato varieties have very high yields, indicating that there are technologies available, and access to these would allow farmers to use these opportunistically, with high yields in good years that can be stored as freeze dried potatoes (Chuño). Our research on the diversity of potatoes in the household portfolio shows that Chuño is important for coping strategies, especially for the elderly and the resource poor. On the other hand households with livestock cash activities like dairy have access to credit when crops are lost. Markets have been an incentive to introduce more dairy and potato production. Drought and El Niño Event (also presents as a drought) have decreased livestock assets of the elderly and the households with little access to forages. It has as a result decreased diversity of production. In the productive years, households can make use of information for decisions related to crop varieties/seeds and inputs, soil type and location, and time of planting. Livestock producers delivering milk have found that floods and political unrest affect milk marketing and reduce cash income, but not necessarily increased sales of animals. The elderly most likely benefit through income transfers and temporary employment within the

community, and could benefit from mitigation policies, rather than affecting production decisions.

We found, especially in Peru, that labor markets are important to households with land constraints. Santa Maria's households are in better position of linking to markets to sell livestock products, although Anccaca has more production of livestock.

About Local Knowledge Forecasts and Networks, our research is showing that currently rural households at our sites don't use forecast information from the outside. They know about el Niño, and hear local forecasts in the radio but they don't find the messages to be applicable to their localities. Households use local forecasts that are based on observation of a series of biological and natural indicators, along with dreams. The natural indicators are not the sole source of information. This is combined with observations of plants, and behavior of animals. These seem to indicate that local conditions (soil type, location, fertility and moisture) and natural conditions (observation of constellations, frosts at certain times of year, and wind intensity and direction) are elements of a forecast for the type of year and for the presentation of the rains. Their indicators provide a set of rules of what to do (or not do) when observations are made. The network analysis is showing also that for crop production, nodes of information are those trusted producers. They are trusted because they are good farmers, *buenos paperos* (good potato producers). We expect that this research will provide insights into the type of information that is useful to producers in the Andes. Finally our CIP collaborators are now including the approach on livelihood strategies in the design of a Challenge Program on Sustainable Mountains.

B. Describe how this research builds on previously funded research funded by HDGEC

Previous research in Fisheries in Peru and Agricultural Producers in Brazil found that there are asymmetries in access to information and that not all benefit in the same way. Research in Brazil indicated that only some households could benefit because of lack of alternatives with poorer families. We are finding that access is asymmetric and some households would benefit more than others from information on climate forecasts, because it would allow more vulnerable groups to opportunistically benefit from technologies (seed potato varieties that are clean) when a good season occurs.

A summary of who would benefit from information in Africa (Blench) indicated that those with more specialized activities and greater resources to withstand a loss would benefit from climate forecast information. We find that families with more resources are more diversified, and are not as dependent on the outcome of the climate, as those that rely on crop production.

Research on local knowledge forecasts for the Andes indicates that observation of the Pleiades has a relation to El Niño (Cane, Orlove and Chiang's research). Our research shows that farmers look at the constellations, but also look at other indicators, which may be pointing to local characteristics as also very important in crop planting decisions. The models that CIP is calibrating also seem to point to this.

C. How is your project explicitly contributing to the following areas of study?
(one paragraph per relevant areas)

1. Adaptation to long term climate change: our research is looking to the role of market and non market institutions that facilitate coping and adaptation in the highlands. The panel research in Bolivia is especially important as observations span a decade and show the changing behavior of households. They are responding to market incentives and government policies in their change of technologies (introduction of dairy and commercial potato varieties), but their integration to markets is partial, which indicates that understanding non market institutions and their role in coping should provide insights into adaptation.
2. Natural Hazards Mitigation: Droughts, floods and frosts are the major natural hazards affecting the Altiplano households. Findings on coping strategies, the role of women, and their use of assets (as well as asset depletion) will inform NGOs working on relief, in terms of interventions that can help households cope with the lag effects (lack of seed and lack of food are felt also in the next production year) of natural hazards mitigating the depletion of human capital.
3. Institutional dimensions of global change: our study focus on how the rural communities look out, to the forecasting community and other institutions that target reduction of vulnerability. At this time we are only looking at causes for the lack of linkages between them.
4. Economic value of climate forecasts: in this research we are looking at the households that would benefit from access to information, and at the household typology in relation to access to information. We expect that the integration of the biological models with the strategies will allow for simulation of events and outcomes, which will allow us to identify that benefits. At this time there is not use of “outside” forecast information.
5. Developing tools for decision makers and end-users: see point four. We hope that the biological models that are being calibrated would be useful in value added products of forecast information.
6. Sustainability of vulnerable areas and or people: our focus is the Andean region. This is a region characterized by an environment that is fragile, and rural populations that are among the poorest of the region. Our understanding of the relationship between the effects of climate and other factors like markets, policies and non market institutions, in a framework that looks at the relationship between the capitals (natural, human, social, productive), as well as diversification, should provide insights into resiliency and adaptation.
7. Matching new scientific information with local indigenous knowledge: this has not been part of our project, though members of our expert panel have suggested that the information on local knowledge can be correlated to observations of natural phenomena. Our project does not have the funding to cover this research.

8. The role of public policy in the use of climate information: we have proposed research in this area as we consider it an essential next step in bridging the gap between potential users and producers or processor of forecasts.
 9. Socioeconomics impacts of decadal climate variability: in terms of insights our panel study of Bolivia highlights the interrelationship that exists between the climate variability impact and that of markets and policies. When households have more flexibility to engage in several economic activities they have less need to deplete their capital assets (livestock mostly). Changes in the diversity index are measuring this.
 10. Other: Our research has a gender dimension as the livelihoods and household portfolios framework looks at the role of individuals in securing the welfare of the family. The case study research in Bolivia shows that women manage the diversity of potatoes. Previous research also showed that women control the income of sheep that is invested in human capital (welfare expenditures in nutrition, health and education). The impact of negative shock events in resource poor households results in pooling out children from school.
- III. Graphics- Please include the following graphics as attachments to your report
- A. Graphic Depicting Overall Project Framework and Approach (see PowerPoint file ValdiviaIII.A.C.D)
 - B. Annex 1- Biological Models
 - C. Map of region covered by study (PowerPoint file Valdivia III.A.C.D.)
 - D. Photographs from fieldwork to depict study environment (see PowerPoint file ValdiviaIII.A.C.D)
- IV. Website address: <http://www.ssu.missouri.edu/clima>

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